

*BEYOND THE MOMENT: COMPLEX BEHAVIOR
IN TEMPORALLY EXTENDED ENVIRONMENTS*

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Donahoe, Palmer, and Burgos have provided a valuable contribution toward an account that can accommodate order at both the neurological and behavioral levels. Among the attractive aspects of their account are a neural network model that appears to be remarkably effective at simulating behavior–environment interactions at the level of single responses; an emphasis upon the importance of keeping all behavior–environment relations (operant and nonoperant) within our interpretive window; and an excellent discussion of the subtle range of discriminative functions that the contiguous antecedent environment can acquire. In patterning an explanatory account in accord with the kinds of events that are known to occur at the neurological level, they have raised a number of controversial issues for behavior analysts. The present comments will focus primarily on the issue of scales of analysis and the manner in which the relation between the antecedent environment and behavior is construed by Donahoe et al.

Noting that reinforcement strengthens “the environmental control of responding” (p. 193), Donahoe et al. propose that behavior can best be understood as guided by the environment contiguous to it. *Environment*, as they use the term here, refers explicitly and exclusively to current environmental stimulation, the momentary antecedent context of the behavior in question:

When input units are stimulated by the simulated occurrence of environmental stimuli, the interior units to which those input units are connected are probabilistically activated in the following moment. If a reinforcing signal is present at that moment, then connections are strengthened between input units and all recently activated interior units to which they are connected. (p. 203)

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It is this aspect of their account that prompted Shull (1995b) to remark on the similarities between their account and traditional S-R theories.

Although it is likely that the immediately antecedent environment often exerts control, it seems unnecessarily constraining to limit the instantiating functions of the environment only to that moment. As Skinner noted,

The analysis of behavior is not an act of arbitrary subdividing, and we cannot define the concepts of stimulus and response quite as simply as “parts of behavior and environment” without taking account of the natural lines of fracture along which behavior and environment actually break. (1935/1959, p. 347)

To subdivide the environment, as Donahoe et al. appear to do, into successive moments of stimulation acting upon individual responses precludes an analysis based upon “natural lines of fracture” that may reveal the importance of larger aspects of the environment and larger patterns of behavior.

Although Donahoe et al. have provided a plausible model of simple responses on a momentary level, the generality of that model in accounting for larger units of behavior and more temporally extended aspects of the environment remains unclear, at least to this reader. Their neural network simulation, as they presently describe it, appears to be locked into a particular molecular time scale. The account has yet to capture what some consider to be an important aspect of behavior-analytic accounts, that being the ability to handle multiple scales of behavioral process with a remarkably small set of defining principles. The same principles that account for a red light evoking a lever press can account for temporally extended behavior–environment relations such as engaging in arguments or running marathons.

*Behavioral Patterns and Larger
Units of Behavior*

One of Skinner’s most important contributions to the development of a science of

behavior was his conception of rate as a fundamental dimension of behavior (Hineline, 1990; Skinner, 1938, 1956; also see Shull, 1995b). Building upon that innovation, as behavior analysts have done, intrinsically involves analyses extended in time, for one cannot derive rate from isolated single responses. At any particular moment, a rate may be present even while its constituent events are not visible. It follows that the instant, the setting, the situation, and other spatiotemporally contiguous elements attendant to a specific response are not *necessarily* to be given privileged status.

In support of their position on the control exerted by the contiguous environment, Donahoe et al. cite Skinner's (1976) lament of the decline of the cumulative record, but they fail to convey that aspect of the cumulative record which he found most compelling:

The additional information to be found in a simple cumulative record, where for the first time [the observer] can estimate rate of responding accurately, compare different rates, and follow the accelerations which are now obvious. (Skinner, 1969, p. 9)

That is, if sufficiently magnified, a cumulative record does provide information regarding moment-to-moment stimulation as it relates to moment-to-moment responding, but, more importantly, viewed at lesser magnification it allows one to observe changes in rate across time as they relate to changes in the environment. After devising the cumulative record, Skinner could observe the development of patterns of responding under the control of relevant, not necessarily contiguous, aspects of the environment. Consider, for example, the scallop pattern of responding that is acquired and maintained on a fixed-interval schedule of reinforcement. That pattern is most appropriately described as a pattern of behavior that is under control of a temporally extended aspect of the environment (the relation between periodically available food deliveries) rather than as responses evoked by momentary stimulus situations.

The Temporally Extended Environment

For Donahoe et al., responding is necessarily evoked by the environment of the prior moment, and, although the precise temporal

dimensions of the moment are not specified, their descriptions suggest that it is brief. Thus, although they have acknowledged the contribution of the temporally extended environment to behavioral selection (pp. 203–204), they have not yet incorporated its relevant instantiating functions. Those functions include evocative (e.g., discriminative) and alterative (e.g., conditional and motivative) relations that account for behavioral occurrences (Glenn & Field, 1994). Time is a critical dimension of the environment, present even in very punctate events. The importance of its inclusion becomes apparent when one considers the extent to which relations between temporally dispersed features of the extended environment can be functionally related to behavior, considered here in terms of (a) duration, (b) rate, and (c) more complex relations.

Duration. Temporal discrimination tasks with pigeons (e.g., Fetterman, Dreyfus, & Stubbs, 1989) and avoidance conditioning studies with rats (e.g., Mellitz, Hineline, Whitehouse, & Laurence, 1983) have demonstrated the behavioral relevance of duration. Mellitz et al. found that when offered a choice between two otherwise equal shock-postponement procedures that were concurrently available, rats preferred the alternative in which a session-shortening contingency was also operative. They found that reductions in the duration of the avoidance session came to control choice even though the local (moment-to-moment) differences between alternatives were explicitly arranged to be indistinguishable.

Rate. Just as rate of occurrence is a fundamental dimension of responding, it is also a fundamental dimension of events that acquire function with respect to behavior. Herrnstein and Hineline (1966) demonstrated that a reduction in the overall rate of electric shock was sufficient to generate and maintain avoidance responding. Environmental rate also plays a key role in adjunctive behavior. For instance, the rate of food presentations is the primary variable that controls polydipsia in rats. When food deliveries occur at a particular frequency (the operative frequency varies across subjects, between 30 s and 180 s), a rat will consume much more than its normal daily water intake (Falk, 1966; Hineline, 1981; Wetherington, 1979, 1982).

In these two examples, it is the relation between environmental events (food deliveries or shocks distributed over time), rather than any specific momentary instance of either, that controls responding.

More complex relations. Beyond duration and rate, there are other invariant relational aspects of an extended environment (Gibson, 1966, 1979; Michaels & Carello, 1981; see also Fetterman, Stubbs, & MacEwen, 1992; Glenn & Field, 1994, Footnote 2). For instance, Shull (1995a) proposes that contingencies and contingent relationships, as discriminable relations, are “*molar* features of the environment rather than something that one can point to as occurring at this or that moment in time” (p. 145). He continues with a further elaboration:

Contingencies are molar in the same sense that rhythm is a molar property of music. One cannot detect rhythm by considering only the individual notes because the term *rhythm* refers to the *pattern* of relationships among the individual notes. The pattern (i.e., the rhythm) is just as much a physical property of the music as the individual notes are; but the property that we call rhythm is, of its essence, molar in the sense of being extended over time and relational. (p. 145)

Any comprehensive account of the environmental control of behavior, including that of complex behavior, must eventually include control evidenced by such temporally extended aspects of the environment.

Order at Multiple Scales of Process

In focusing exclusively on the “momentary relations between environmental and behavioral events” (p. 201), Donahoe et al. take an implicitly reductionist stance in which it must be assumed that ultimately a particular molecular level can account for order at all levels. A potential embarrassment to any reductionist argument is that the particular scale proposed as molecular can itself be further reduced: There will always be more molecular levels of analysis. It is easy to see how an analysis of process at the level of the single input unit or a single neuron might occlude much relevant order. I suggest, then, that further elaborations of the model incorporate greater flexibility in transition between scales. To respond with sensitivity to order at multiple scales, one must recognize that although

process at more molar scales cannot violate regularities at molecular levels, the order found at any given level may not necessarily be more predictive than, or anticipate organization at, other levels. Indeed, neural network models may prove to be particularly well suited to studying both molecular and molar processes that proceed simultaneously at the neurological level (e.g., Wright & Liley, 1996).

The neural network simulation set forth by Donahoe et al. provides a valuable contribution to the development of a selectionist account that is compatible with phenomena found at both the neurological and the behavioral levels. A neural network interpretation that accommodates order at multiple, simultaneous, or overlapping scales of process will provide an even more powerful explanatory model. Such a model, elaborated to incorporate spatiotemporally dispersed components of behavior and environment, would retain what we have come to see as a critical element of behavior-analytic interpretation:

When order is not apparent at a molar level, a more molecular analysis may be necessary (cf. Moore, 1982). Conversely, if one fails to find an immediate stimulus that controls a response, perhaps the response is only an element of a larger functional unit which is controlled by currently operating variables not immediately attendant to that element. (Morris, Higgins, & Bickel, 1982, pp. 119–120)

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IN TODAY'S CLIMATE, A FORECAST FOR CHANGE:
A COMMENTARY ON DONAHOE,
PALMER, AND BURGOS

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Donahoe, Palmer, and Burgos' essay raises several interesting questions concerning the future of the analysis of behavior, independent of whether neural networks ultimately turn out to be the potent biobehavioral models the authors suggest. The real difficulty that thwarts the authors' attempted convergence of behavioral systems appears not to be the conceptual nature of the S-R issue, but rather procedural and measurement differ-

ences that have evolved following the divergence of operant and classical learning traditions.

Skinner's conception of the operant never denied antecedent controlling stimuli, but only ones that were reliably observable. Rather than postulate their existence as a matter of first principles, Skinner ignored them and concentrated instead on the reliable relation at the other end of the behavior–environment interaction, the R-S relation.

An event may occur without any observed antecedent event and still be dealt with adequately in a descriptive science. I do not mean that there are no originating forces in spon-

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